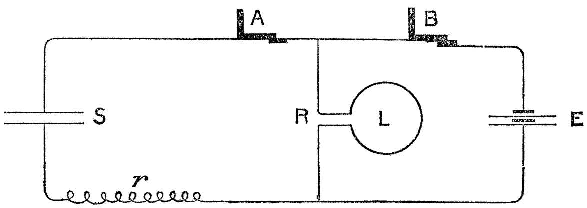
the metal in each case. Lithium chloride gives no continuous spectrum.

The Volatility of Metals.—One of the most interesting facts ascertained by this investigation is the volatility of all the metals examined, except platinum, and particularly the extraordinary volatility of manganese, and, to some extent, of the infusible metal iridium. Metal believed to be pure iridium is seen to have diminished after the flame has played upon it for about two hours.

III. "On the Flow in Electric Circuits of Measurable Inductance and Capacity; and on the Dissipation of Energy in such Circuits." By ALFRED W. PORTER, B.Sc., Demonstrator of Physics in University College, London. Communicated by Professor G. CAREY FOSTER, F.R.S. Received May 4, 1893.

The arrangement of the apparatus in the experiments here described was as follows:—



L is a coil of self-inductance L (= 0·42 henry) and of resistance R (= 28 ohms).

S is a condenser of capacity S ($= 5 \times 10^{-6}$ farads), and in the same branch with it is an inductionless resistance, r, the value of which can be varied.

E is a battery which, when the circuits shown are complete, produces a current through L, and charges the condenser.

A and B are the two contact pieces of a pendulum interruptor. The two circuits can be broken at these places by the pendulum: the time interval between the two ruptures being regulated by the distance between the contact pieces.

One centimetre distance apart corresponds to 5·270 thousandths of a second, and, as this distance can be read easily (by a vernier attached) to a tenth of a millimetre, it is possible to measure intervals of

5 hundred-thousandths of a second.

The method of the experiments is as follows:—

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A and B are initially closed; a steady current, x_0, flows in consequence through L, and the condenser is charged to a difference of potential Rx_0. The pendulum breaks contact first at B. This prevents further flow in the battery branch; the coil current is diverted into the condenser branch, and flows there until its energy is wholly dissipated or until its flow is intercepted by the rupture at A. The charge retained by the condenser is then measured by discharging it through a D'Arsonval galvanometer (not indicated on the diagram) which has been calibrated for ballistic use.

This series of operations is successively repeated for many values of the time interval.

It is thus possible to determine the charge of the condenser at any moment after the rupture of the battery branch. Some of the results obtained are shown in fig. 1 and fig. 2. The ordinates represent the charges in arbitrary units; the abscissæ give the time in thousandths of a second.

The data for the curves are as follows:—

		Value of r in ohms.	Inductance in henries.	Capacity in farads.
Fig. 1	Curve A....	10,000	0·42	5×10^{-6}
	Curve B....	3,100	,,	,,
	Curve C....	552	,,	,,
Fig. 2		0	,,	,,

Fig. 1, Curve A represents a merely leaking discharge;

Curve B represents the critical discharge that just fails to ever charge the condenser negatively;

Curve C represents the critical discharge that just fails to be oscillatory;

And the curve in fig. 2 represents a typical oscillatory discharge.

To find from theory what these curves should be, we must solve the equation

$$\left\{ L \frac{d^2}{dt^2} + \rho \frac{d}{dt} + \frac{1}{S} \right\} Q = 0,$$

where ρ is the dissipation constant, and Q is the charge at any instant. The constants of integration must be determined to suit the conditions that

$$Q_{t=0} = Q_0;$$

$$\left\{ -\frac{dQ}{dt} \right\}_{t=0} = x_0 = \frac{Q_0}{RS}.$$

The solution has one of two forms according as

$$\rho^2 \gtrless \frac{4L}{S}.$$

In the former case it becomes finally

$$Q = \frac{Q_0 \epsilon^{-mt}}{2n} \left\{ \left(m + n - \frac{1}{RS} \right) \epsilon^{nt} + \left(\frac{1}{RS} - m + n \right) \epsilon^{-nt} \right\},$$

where $$m = \frac{\rho}{2L}$$

and $$n = \sqrt{\left(m^2 - \frac{1}{LS} \right)}.$$

In the second case let $p^2 = -n^2$, and the solution is

$$Q = Q_0 \epsilon^{-mt} \sec \phi \, . \cos (pt + \phi),$$

where $$\tan \phi = \frac{\frac{1}{RS} - m}{p}.$$

Calculating and plotting the curve for the case in fig. 2 on the assumption that ρ is equal to the wire resistance in the circuit (28 ohms), the dotted curve in the same figure is obtained. The time periods of the two agree very well; but a marked difference is seen in the rate of shrinkage of the ordinates.

The explanation that offered itself is that the wire circuit is not the only seat of dissipation of energy, but that dissipation also takes place in the dielectric of the condenser. In accordance with this, it is possible to reproduce the experimental curve by increasing the value of ρ to 59·43 ohms. Points on the curve so determined are shown as solid dots in the figure. The agreement of the time periods is also improved by this increase in ρ, as can be seen from the following table:—

	Calculated from $\rho = 28$.	Calculated from $\rho = 59{\cdot}43$.	Observed.
Time period in seconds....	0·009116	0·009154	0·009147

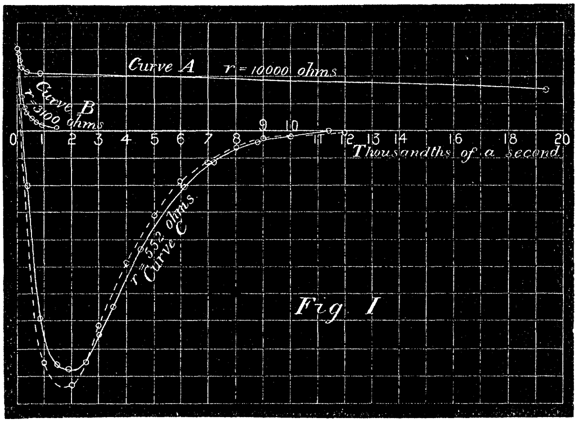
The experiment has also been repeated with soft iron rods inserted in the coil. These are rather longer than the coils, and their diameters are—

No. I	1·93 cm.
No. II	1·30 ,,
No. III	0·65 ,,

The other data were the same as for fig. 2. The curves obtained are shown in fig. 3, and are numbered I, II, III, according to the rod employed. Their chief characteristics are :—

α. A change in time period as the discharge progresses.

β. Rapid decrement.



Curve A r = 10000 ohms
Curve B r = 3100 ohms
r = 552 ohms Curve C
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 18 20
Thousandths of a second
Fig. I

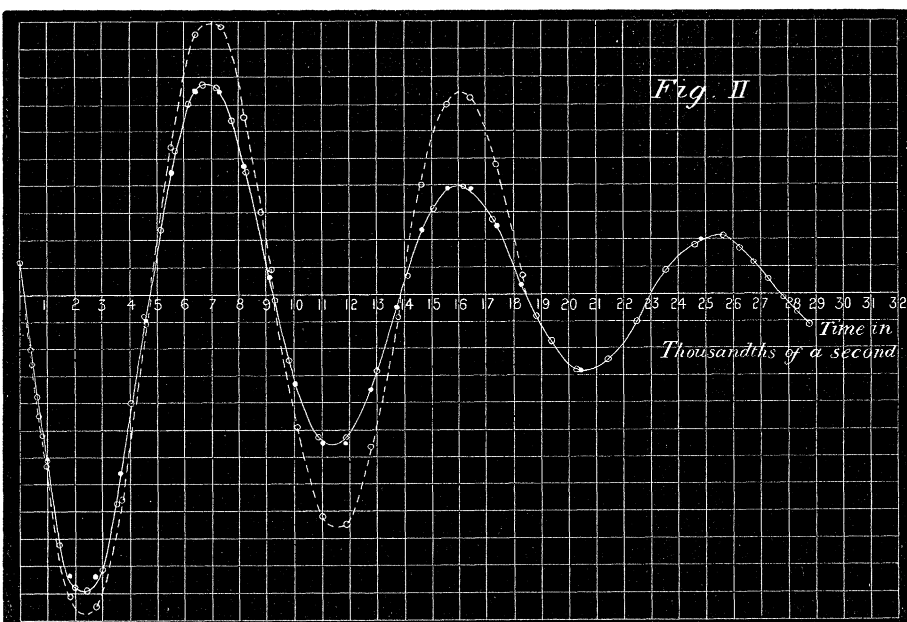
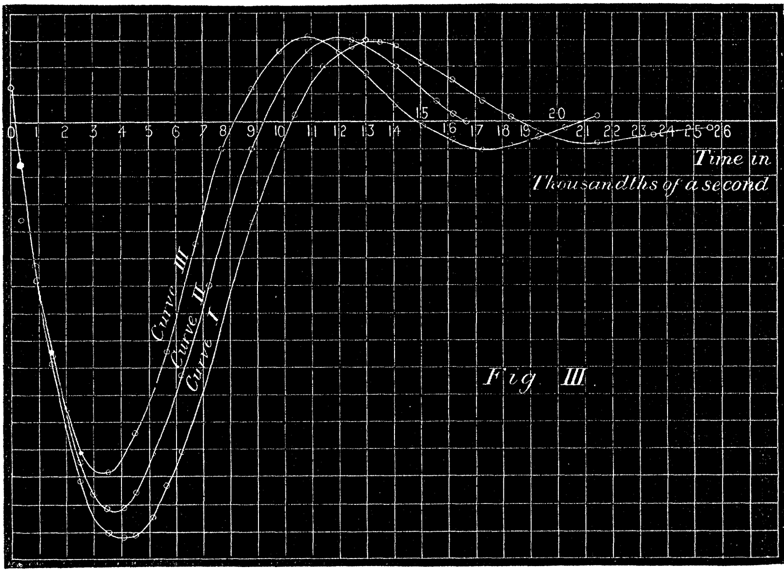


Fig. II
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Time in Thousandths of a second



That this latter is only very partially due to eddy currents in the iron was shown by repeating the experiment with a brass rod of 2 cm. diameter inserted in the coil. The curve obtained is only slightly (though distinctly) different from that obtained without any core.

Experiments have also been begun on the decay of current in circuits containing iron and of negligible capacity. The coil possessing the inductance forms one arm of a Wheatstone's bridge. These experiments were commenced as far back as June, 1890; the experiments described above were commenced in January, 1891. Both series were suspended for want of a sufficiently precise interruptor. This has since been obtained, and satisfactory work has thus been made possible. The investigation is only in an early stage; but the fact that at least one other observer* is already working in the same field induces me to present this preliminary note in order to show the independence of our work.

* P. Janet. See 'Comptes Rendus,' vol. 115, Nos. 21 and 26; vol. 116, No. 8.

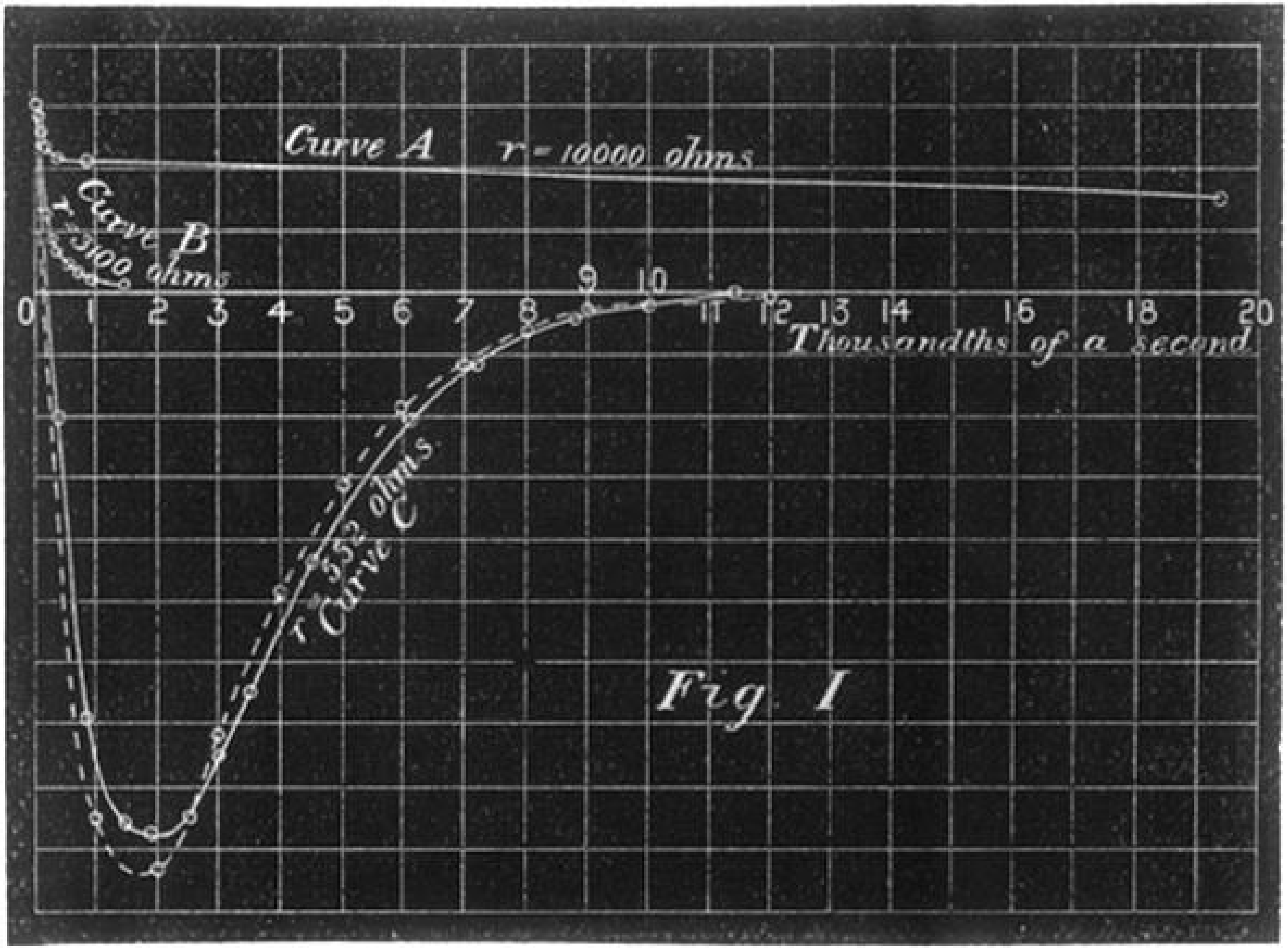

Curve A r = 10000 ohms
Curve B r = 3100 ohms
Curve C r = 552 ohms
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 18 20
Thousandths of a second

Fig. I

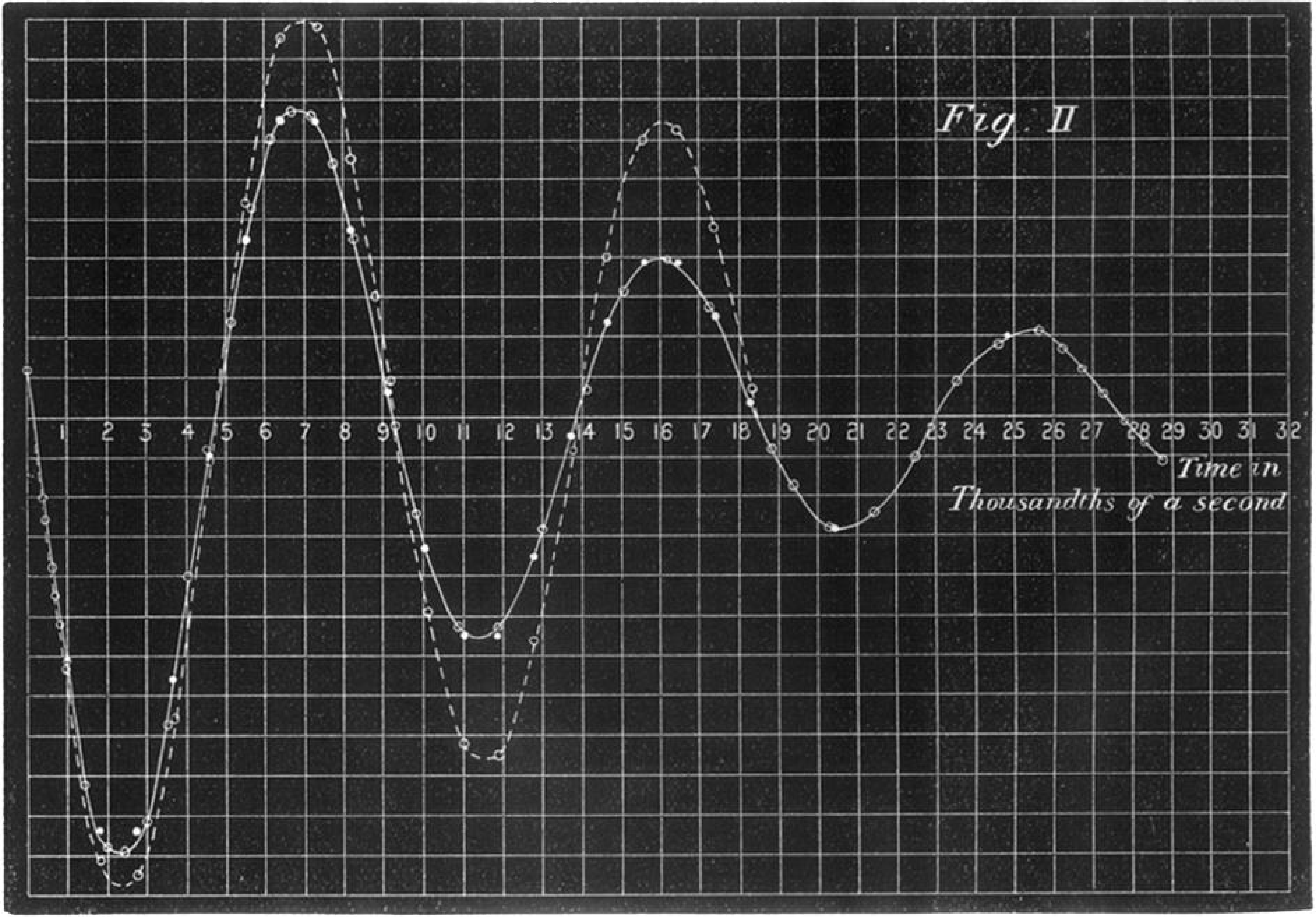
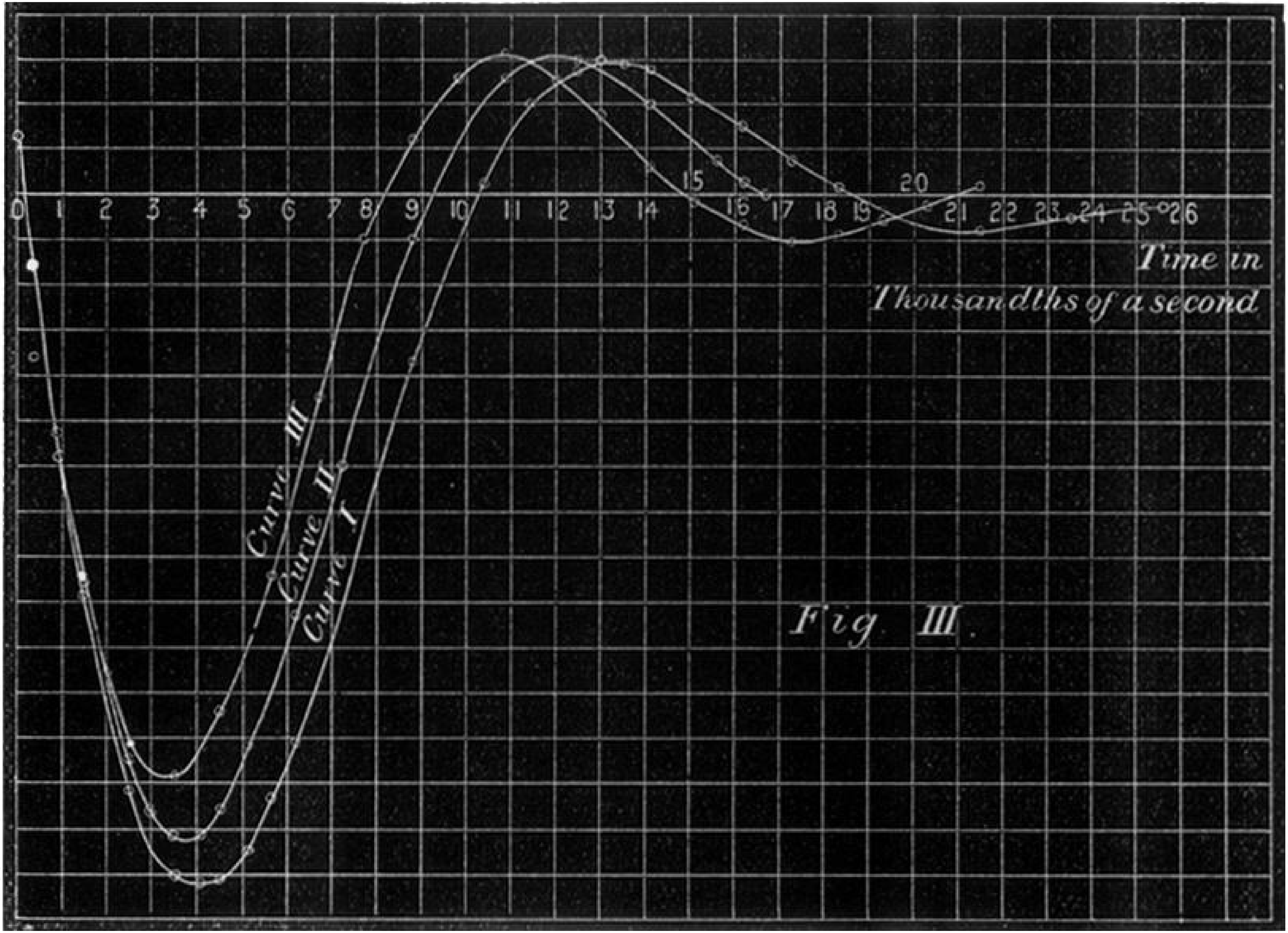


Fig. II
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Time in
Thousandths of a second



0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Time in
Thousandths of a second
Curve III
Curve II
Curve I

Fig. III.